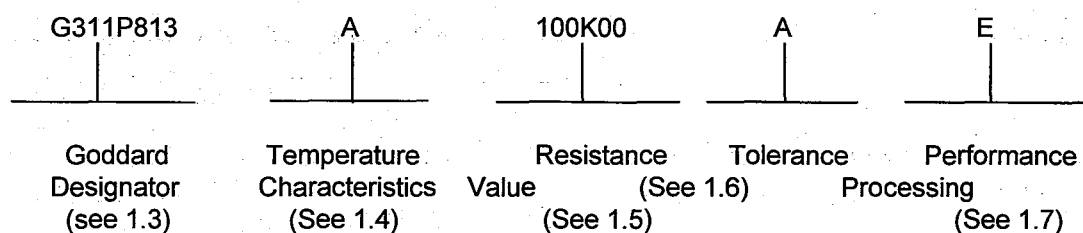


REVISIONS																				
SYMBOL	DESCRIPTION												DATE	APPROVAL						
--	<ul style="list-style-type: none"> Original Release 												12/10/96	J. Bollman						
A	<ul style="list-style-type: none"> Corrected the Power Conditioning Test Condition from 1.5 W to 1.0 W. Addition of Standard Resistance Value Decade Table. 												11/04/97	J. Bollman						
B	<ul style="list-style-type: none"> Changed the Post Test Delta R allowances to include an additional 0.001 ohms beyond the percent shift allowed. Revision A allowed additional 0.010 ohms which was a typo (see page 6) Moved DWV and IR from Group B to Group C test and created a new Group C subgroup with DWV, IR and Terminal Strength (see pages 18, 19) Modified the method for Resistance to Solder Heat (test now requires both Hand Solder and Wave Solder and methods) (see page 23) Changed responsible GSFC organization from Code 311 to Code 562 (see pages 14 and 28) 												03/09/98	J. Bollman						
C	<ul style="list-style-type: none"> Modified the DPA Pass/Fail Criteria for line width Redefined the term "inspection lot" Added option for vendor to add additional markings 												08/16/99	J. Bollman 						
SHEET REVISION STATUS																				
SH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
REV	C	B	B	B	B	B	B	B	B	B	B	C	B	B	B	C	B	B	B	C
SH	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
REV	B	B	B	B	B	B	B	B												
ORIGINATOR: J. A. Brusse/Unisys													DATE 11/04/97		FSC: 5905					
APPROVED: H. Milteer/Unisys													11/04/97		Resistor, Fixed, Low Temperature Characteristic, Precision, Radial-Lead					
CODE 311 APPROVAL: M. J. Sampson/GSFC													11/04/97							
CODE 311 SUPERVISORY APPROVAL: G. P. Kramer, Jr./GSFC													11/04/97							
ADDITIONAL APPROVAL:															S-311-P-813					
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION GODDARD SPACE FLIGHT CENTER GREENBELT, MARYLAND 20771 CAGE CODE: 25306																				

1. SCOPE

1.1 Scope. This specification covers the procurement requirements for fixed, low temperature coefficient, precision radial-leaded resistors. These resistors are intended for use in NASA/GSFC space system electronic circuits requiring extreme temperature stability. Four levels of temperature coefficient of resistance are specified ranging from ± 2.5 ppm/ $^{\circ}\text{C}$ to ± 20 ppm/ $^{\circ}\text{C}$. In addition, optional performance requirements may be specified by the procurement activity as required for the intended application.

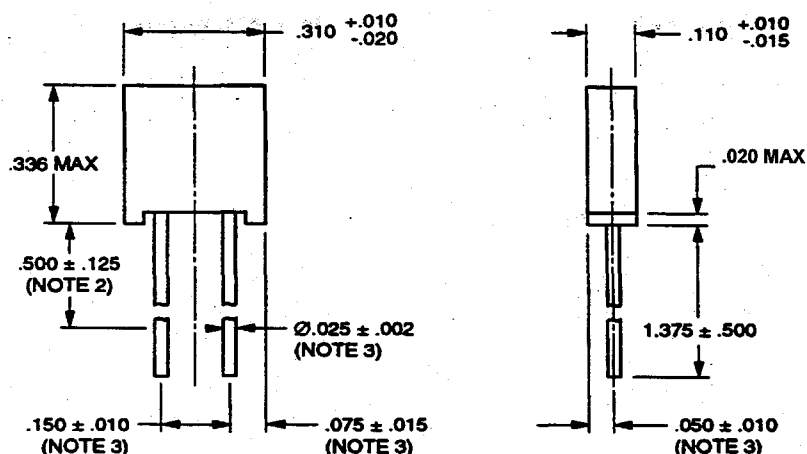
1.2 Goddard part number. Parts procured in complete compliance with the requirements of this specification shall be identified by a Goddard part number of the following form.



1.3 Goddard designator. The Goddard designator specifies resistors of a type and style listed in Figure 1 and Tables I through V.

Table I. - G311P813 resistor characteristics.

Power Rating @ 125°C	Maximum Working Voltage	Operating Temperature Range	Temperature Characteristic of Resistance (Table II)	Resistance Range		Tolerances (Table IV)
				Minimum	Maximum	
0.3 W	300 Vdc	-55°C to +125°C	D	1 Ω	2.99 Ω	D, F
			C	3 Ω	4.99 Ω	D, F
			C	5 Ω	9.99 Ω	B, D, F
			B, C	10 Ω	29.99 Ω	B, D, F
			B, C	30 Ω	99.99 Ω	V, T, Q, A, B, D, F
			A, B, C	100 Ω	100 k Ω	V, T, Q, A, B, D, F



Note 1. Dimensions are in inches.

Note 2. Resistance measurements point.

Note 3. The lead measurement is made from the point of emergence from the body.

Note 4. Style of standoffs is optional.

Figure 1. - Resistor outline drawing.

- 1.4 Temperature characteristic. The temperature characteristic of resistance (TCR) is applicable to any resistance value within the given standard resistance range (see Table I). The temperature characteristic codes are listed in Table II.

Table II. - Temperature characteristic of resistance.

Characteristic Code	Temperature Range	Temperature Characteristic (reference to +25°C)
A	-55°C to +125°C	± 2.5 ppm/°C
B	-55°C to +125°C	± 5.0 ppm/°C
C	-55°C to +125°C	± 10.0 ppm/°C
D	-55°C to +125°C	± 20.0 ppm/°C

- 1.5 Resistance value. The nominal resistance value is specified by a series of six characters, five of which represent significant digits while the sixth, the letter R or K, is a dual purpose letter which indicates both the value range (R for ohmic, K for kilo-ohmic) and the location of the decimal point.

examples: 50R000 = 50.000 ohms
 619R00 = 619.00 ohms
 42K200 = 42.200 kilohms
 100K00 = 100.00 kilohms

Any resistance value may be selected within the ranges listed in Table I. However, it is preferred that resistance values be selected from the standard decade values listed in Table III.

Table III. - Standard Resistance Values for the 10 Decade to 100 Decade 1/

≤0.1% (V,T, Q,A,B)	0.5% (D)	1.0% (F)	≤0.1% (V,T, Q,A,B)	0.5% (D)	1.0% (F)	≤0.1% (V,T, Q,A,B)	0.5% (D)	1.0% (F)	≤0.1% (V,T, Q,A,B)	0.5% (D)	1.0% (F)
10.00	10.00	18.40	---	---	32.80	---	---	56.20	56.20	---	---
10.10	---	18.70	18.70	---	---	---	---	56.90	---	---	---
10.20	10.20	18.90	---	---	33.20	33.20	---	57.60	57.60	---	---
10.40	---	19.10	19.10	---	33.60	---	---	58.30	---	---	---
10.50	10.50	19.30	---	---	34.00	34.00	---	59.00	59.00	---	---
10.60	---	19.60	19.60	---	34.40	---	---	59.70	---	---	---
10.70	10.70	19.80	---	---	34.80	34.80	---	60.40	60.40	---	---
10.90	---	20.00	20.00	---	35.20	---	---	61.20	---	---	---
11.00	11.00	20.30	---	---	35.70	35.70	---	61.90	61.90	---	---
11.10	---	20.50	20.50	---	---	---	---	---	---	---	---
11.30	11.30	20.80	---	---	36.10	---	---	62.60	---	---	---
11.40	---	21.00	21.00	---	36.50	36.50	---	63.40	63.40	---	---
11.50	11.50	21.30	---	---	37.00	---	---	64.20	---	---	---
11.70	---	21.50	21.50	---	37.40	37.40	---	64.90	64.90	---	---
11.80	11.80	21.80	---	---	37.90	---	---	65.70	---	---	---
12.00	---	---	---	---	38.30	38.30	---	66.50	66.50	---	---
12.10	12.10	22.10	22.10	---	38.80	---	---	67.30	---	---	---
12.30	---	22.30	---	---	---	---	---	---	---	---	---
12.40	12.40	22.60	22.60	---	39.20	39.20	---	68.10	68.10	---	---
12.60	---	22.90	---	---	39.70	---	---	69.00	---	---	---
12.70	12.70	23.20	23.20	---	40.20	40.20	---	69.80	69.80	---	---
12.90	---	23.40	---	---	40.70	---	---	70.60	---	---	---
13.00	13.00	23.70	23.70	---	41.20	41.20	---	71.50	71.50	---	---
13.20	---	24.00	---	---	41.70	---	---	72.30	---	---	---
13.30	13.30	24.30	24.30	---	42.20	42.20	---	73.20	73.20	---	---
13.50	---	24.60	---	---	42.70	---	---	74.10	---	---	---
13.70	13.70	24.90	24.90	---	---	---	---	75.00	75.00	---	---
13.80	---	25.20	---	---	43.20	43.20	---	75.90	---	---	---
14.00	14.00	25.50	25.50	---	43.70	---	---	76.80	76.80	---	---
14.20	---	25.80	---	---	44.20	44.20	---	77.70	---	---	---
14.30	14.30	26.10	26.10	---	44.80	---	---	78.70	78.70	---	---
14.50	---	26.40	---	---	45.30	45.30	---	79.60	---	---	---
14.70	14.70	26.70	26.70	---	45.90	---	---	80.60	80.60	---	---
14.90	---	---	---	---	46.40	46.40	---	81.60	---	---	---
15.00	15.00	27.10	---	---	47.00	---	---	---	---	---	---
15.20	---	27.40	27.40	---	47.50	47.50	---	82.50	82.50	---	---
15.40	15.40	27.70	---	---	48.10	---	---	83.50	---	---	---
15.60	---	28.00	28.00	---	48.70	48.70	---	84.50	84.50	---	---
15.80	15.80	28.40	---	---	49.30	---	---	85.60	---	---	---
16.00	---	28.70	28.70	---	49.90	49.90	---	86.60	86.60	---	---
16.20	16.20	29.10	---	---	50.50	---	---	87.60	---	---	---
16.40	---	29.40	29.40	---	---	---	---	88.70	88.70	---	---
16.50	16.50	29.80	---	---	51.10	51.10	---	89.80	---	---	---
16.70	---	---	---	---	51.70	---	---	90.90	90.90	---	---
16.90	16.90	30.10	30.10	---	52.30	52.30	---	---	---	---	---
17.20	---	30.50	---	---	53.00	---	---	92.00	---	---	---
17.40	17.40	30.90	30.90	---	53.60	53.60	---	93.10	93.10	---	---
17.60	---	31.20	---	---	54.20	---	---	94.20	---	---	---
17.80	17.80	31.60	31.60	---	54.90	54.90	---	95.30	95.30	---	---
18.00	---	32.00	---	---	55.60	---	---	96.50	---	---	---
18.20	18.20	32.40	32.40	---	---	---	---	97.60	97.60	---	---
---	---	---	---	---	---	---	---	98.80	---	---	---

1/ The resistance values for tolerances V, T, Q, A and B may be of any value within the limits specified in Table I. However, it is preferred that resistance values be selected from the standard decade values listed in Table III.

- 1.6 Tolerance. The resistance tolerance is identified by a single letter in accordance with Table IV.

Table IV. - Resistance tolerance

Letter	Resistance Tolerance
V	$\pm 0.005\%$
T	$\pm 0.01\%$
Q	$\pm 0.02\%$
A	$\pm 0.05\%$
B	$\pm 0.1\%$
D	$\pm 0.5\%$
F	$\pm 1\%$

- 1.7 Performance option. A single letter in accordance with Table V shall be used to specify parts capable of meeting the requirements for the current noise (see 3.20), voltage coefficient (see 3.21), and thermal EMF (see 3.22) tests.

Table V. - Performance option

Letter	Performance Option
E	Current Noise (see 3.20), Voltage Coefficient (see 3.21) and Thermal EMF (see 3.22)
N	No Special Inspection (i.e., no Current Noise, Voltage Coefficient or Thermal EMF)

- 1.8 Post test requirements. Resistors procured to this specification shall meet the post test requirements specified in Table VI.

Table VI. - Post test requirements.

Test	Requirement
Thermal Shock (See 3.5) 1/	$\Delta R \pm (0.05\% + 0.001\Omega)$
Overload (See 3.6) 1/	$\Delta R \pm (0.05\% + 0.001\Omega)$
Power Conditioning (See 3.7)	$\Delta R \pm (0.05\% + 0.001\Omega)$
Dielectric Withstanding Voltage (See 3.9)	$\Delta R \pm (0.02\% + 0.001\Omega)$
Insulation Resistance (See 3.10)	$> 10,000 \text{ M}\Omega$
Low Temperature Storage and Operation (See 3.11)	$\Delta R \pm (0.05\% + 0.001\Omega)$
Terminal Strength (See 3.12)	$\Delta R \pm (0.02\% + 0.001\Omega)$
Resistance to Soldering Heat (See 3.13)	$\Delta R \pm (0.02\% + 0.001\Omega)$
Moisture Resistance (See 3.14)	$\Delta R \pm (0.05\% + 0.001\Omega)$
Shock (See 3.15)	$\Delta R \pm (0.01\% + 0.001\Omega)$
Vibration (See 3.16)	$\Delta R \pm (0.02\% + 0.001\Omega)$
High Temperature Exposure (See 3.19)	$\Delta R \pm (0.05\% + 0.001\Omega)$
Current Noise (See 3.20) (When specified. See 1.2)	-32 dB max.
Voltage Coefficient (See 3.21) [Applicable to 1,000 ohms and over] (When specified. See 1.2)	0.0005 %/V
Thermal EMF (See 3.22) (When specified. See 1.2)	1 $\mu\text{V}/^\circ\text{C}$ max.
Life (See 3.23)	$\Delta R \pm (0.05\% + 0.001\Omega)$ 0 to 2000 hours $\Delta R \pm (0.2\% + 0.001\Omega)$ 2000 to 10000 hours

1/ The change in resistance shall not exceed the limit specified after the Thermal Shock and Overload tests combined.

2. APPLICABLE DOCUMENTS

2.1 Documents. The following documents, of the issue in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

MIL-I-45208	Inspection Systems Requirements
MIL-PRF-122	Resistors, Fixed, Precision, Established Reliability, General Specification For
MIL-PRF-55182	Resistors, Fixed, Film, Chip, Established Reliability, General Specification For
MIL-R-39032	Resistors, Packaging Of
S-311-M-70	Specification for Destructive Physical Analysis (DPA)

STANDARDS

MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-1276	Leads for Electronic Component Parts
MIL-STD-1285	Marking of Electrical and Electronic Parts
MIL-STD-1580	Destructive Physical Analysis for Electronic, Electromagnetic, and Electromechanical Parts

2.2 Order of precedence. In the event of any conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence. However, nothing in this text shall supersede applicable laws and regulations unless a specific exemption has been obtained.

2.3 Copies of documents. Copies of federal and military documents can be obtained from:

Standardization Document Order Desk
700 Robbins Avenue, Building #4-Section D
Philadelphia, PA 19111-5094

Copies of ASTM publications are available from:

American Society for Testing and Materials
1916 Race Street
Philadelphia, PA 19103

3. REQUIREMENTS

3.1 Qualification. Resistors furnished to this specification shall be product which has been granted qualification approval by NASA/GSFC. Qualification approval shall be based on the following criteria.

3.1.1 Design and source approval. Prior to qualification, the manufacturer's facility may be subjected to survey at the option of GSFC, by the Office of Flight Assurance, GSFC or their designee. Compliance with MIL-I-45208 or equivalent is required. During a survey the history and detailed engineering of the specific resistor design will be reviewed, as will the documented manufacturing and quality control procedures. Only those sources approved in the design and source approval phase shall be eligible for qualification or award of contract under this specification. Source approval and design approval do not constitute part qualification or an equivalent thereof.

3.1.2 Part qualification. Resistor product granted qualification shall be that which has passed the qualification inspection requirement of this specification (see 4.3). Prior to initiation of qualification testing, the manufacturer is encouraged to submit a detailed qualification plan to the qualifying activity (see 4.3.5) to ensure the plan meets the intentions of this specification.

3.2 Materials.

3.2.1 Materials. Materials shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the resistors to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of finished product.

3.2.2 Resistor element lot shelf life. The maximum age for resistor elements used in the manufacture of resistors to this specification shall be 2 years. This resistor element lot shelf life is the time between completion of resistor element manufacture and the start of final assembly.

3.3 Design and construction. Resistors shall be of the design, construction and dimensions depicted in Figure 1. In addition, resistor constructions using a thin metal foil element shall include a flexible intermediate conductor between the terminal lead and the foil (ex., a metal ribbon or thin wire).

3.3.1 Terminal leads. Terminal leads shall be made of solid copper alloy conductors which are solderable/weldable (type C32 or C52 of MIL-STD-1276) to meet the solderability requirement (see 3.17).

- 3.3.2 Insulation. Resistors shall be covered with a molded encapsulant to provide suitable protection to the resistor body.
- 3.3.3 Operating temperature range. The operating temperature range shall be as specified in Table I.
- 3.3.4 Power rating. Power rating is based on continuous full load operation at a rated ambient temperature of +125°C as specified in Table I. For higher ambient temperatures, derating shall be in accordance with Figure 2.
- 3.3.5 Voltage rating. Resistors shall have a rated direct current (dc) continuous working voltage, or an approximate sine wave root-mean-square (rms) continuous working voltage at commercial line frequency and waveform, corresponding to the power rating as determined from the following formula:

$$E = \sqrt{PR}$$

Where:

E = rated dc or rms continuous working voltage

P = power rating (see 3.3.4)

R = nominal resistance

In no case shall the rated dc or rms continuous working voltage exceed the value specified in Table I.

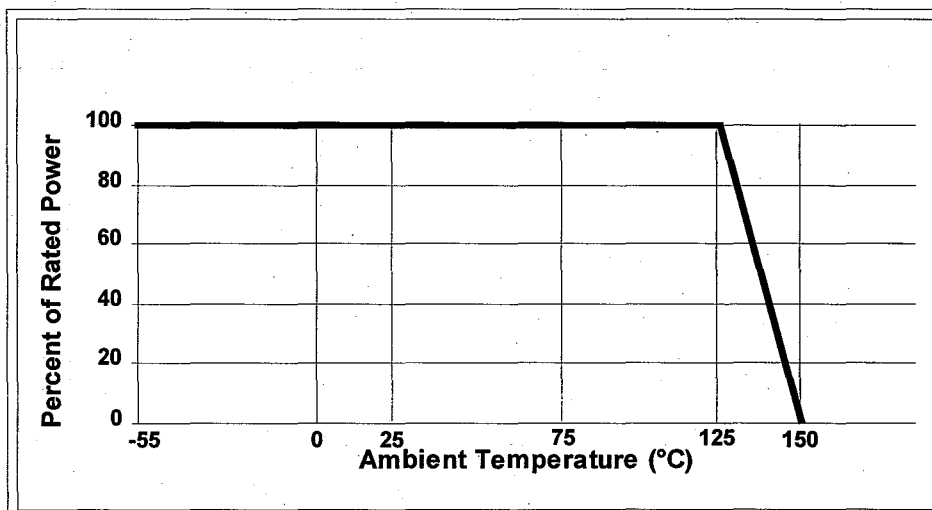


Figure 2. - Resistor derating.

- 3.4 DC resistance. When resistors are tested as specified in 4.6.2, the DC resistance shall be within the specified tolerance of the nominal resistance.
- 3.5 Thermal shock. When resistors are tested as specified in 4.6.3, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the performance requirement in Table VI for thermal shock and overload combined.
- 3.6 Overload. When resistors are tested as specified in 4.6.4, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the performance requirement in Table VI for thermal shock and overload combined.
- 3.7 Power conditioning. When resistors are tested as specified in 4.6.5, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the performance requirement in Table VI.
- 3.8 Temperature characteristic of resistance (TCR). When resistors are tested as specified in 4.6.6, the resistance temperature characteristic shall meet the requirement in Table II.
- 3.9 Dielectric withstanding voltage. When resistors are tested as specified in 4.6.7, there shall be no evidence of flashover, arcing, insulation breakdown, or any type of mechanical damage. The change in resistance shall not exceed the performance requirement in Table VI.
- 3.10 Insulation resistance. When resistors are tested as specified in 4.6.8, the insulation resistance shall meet the performance requirement in Table VI.
- 3.11 Low temperature storage and operation. When resistors are tested as specified in 4.6.9, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the performance requirement in Table VI.
- 3.12 Terminal strength. When resistors are tested as specified in 4.6.10, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the performance requirement in Table VI.
- 3.13 Resistance to soldering heat. When resistors are tested as specified in 4.6.11, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the performance requirement in Table VI.

- 3.14 Moisture resistance. When resistors are tested as specified in 4.6.12, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the performance requirement in Table VI. The change in resistance due to the dielectric withstanding voltage test (see 3.9) shall not exceed the performance requirement of Table VI. In addition, the insulation resistance shall be 100 M Ω , minimum.
- 3.15 Shock. When resistors are tested as specified in 4.6.13, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the performance requirement in Table VI. There shall be no electrical discontinuity during the test.
- 3.16 Vibration. When resistors are tested as specified in 4.6.14, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the performance requirement in Table VI. There shall be no electrical discontinuity during the test.
- 3.17 Solderability. When resistors are tested as specified in 4.6.15, the criteria for wire-lead terminal evaluation that is contained in the referenced test method shall be met.
- 3.18 Resistance to solvents. When resistors are tested as specified in 4.6.16, there shall be no evidence of mechanical damage, and the marking shall remain legible.
- 3.19 High temperature exposure. When resistors are tested as specified in 4.6.17, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the performance requirement in Table VI.
- 3.20 Current noise. When resistors are tested as specified in 4.6.18, the current noise index shall not exceed the performance requirement in Table VI.
- 3.21 Voltage coefficient (applicable to resistors of 1,000 Ω and over). When resistors are tested as specified in 4.6.19, the voltage coefficient shall not exceed the performance requirement in Table VI.
- 3.22 Thermal EMF. When resistors are tested as specified in 4.6.20, the thermal EMF (Seebeck Effect) shall not exceed the performance requirement in Table VI.
- 3.23 Life. When resistors are tested as specified in 4.6.21, there shall be no evidence of mechanical damage, and the change in resistance shall not exceed the performance requirement in Table VI.

3.24 Marking. Each resistor shall be marked with the Goddard part number, manufacturer's name, symbol, or source code and the date code. Date and source code shall be in accordance with MIL-STD-1285. The location and number of lines shall be at the discretion of the manufacturer. The following is an example of the complete marking:

G311P813	- Goddard designator
A100K00AE	- TCR, resistance value, tolerance, performance processing
CAGE Code	- Manufacturer's CAGE Code (If space limitations exist, the manufacturer's name or symbol may be substituted for the CAGE Code as long as it is unique to the particular manufacturing facility)
9632	- Date code

In addition to the above markings, the manufacturer may also include manufacturer specific markings such as the manufacturer's internal part number.

3.24.1 Date code. The date code shall be the date of the final assembly operation for the production lot, which for purposes of this specification, is the same as the inspection lot (4.4.2). The common manufacturing record shall include the same date code as that placed on parts covered by the record. When the physical size of the resistor precludes the marking of all of the above information, the Goddard designator may be abbreviated to 813. However, the complete part number must be marked on the shipping container.

3.25 Workmanship. Resistors shall be processed in such a manner to be uniform in quality when inspected in accordance with 4.6.1. Resistors shall also be free of any defects affecting life, serviceability or performance.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. The manufacturer is responsible for the performance of all inspection requirements, as specified herein, using his own or any other suitable facility acceptable to Goddard Space Flight Center. Upon receipt of product, Goddard reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to verify conformance to prescribed requirements.

4.2 Classification of inspection. Inspection requirements specified herein are classified as follows:

- a. Qualification Inspection (see 4.3)
- b. Quality Conformance Inspection (see 4.4)
- c. Periodic Inspection (see 4.5)

4.2.1 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the "GENERAL REQUIREMENTS" of MIL-STD-202.

4.2.2 Product traceability. A traceability system shall be maintained such that the qualifying activity can trace and determine that the qualified product passed the applicable screening, qualification, and quality conformance inspections. This shall include the ability to trace the exact processes, operators, piece parts and raw materials used in the actual manufacture of the qualified product.

4.3 Qualification inspection (see 4.2). Qualification inspection shall be performed by the manufacturer on sample units produced with equipment, processes and procedures normally used in production. At the option of the qualifying activity, data from an alternate reliability assessment program subjecting same or similar parts to equivalent or more stringent testing may be submitted for part or all of the qualification requirements. Granting of qualification shall be specific to a particular manufacturing facility location. Qualified sources wishing to qualify an alternate manufacturing location must inform the qualifying activity (see 4.3.5) to determine the minimum testing necessary to extend qualification to the alternate location.

4.3.1 Sample. A sample of resistors of each temperature characteristic of resistance (see 1.4), resistance tolerance (see 1.6) and performance option (see 1.7) for which qualification is sought shall be subjected to the qualification inspection specified herein.

- a. The total number of parts required for qualification of each style is 110 for performance option E; 100 for performance option N. The manufacturer may elect to obtain all or part of the Group 6 samples from one of the other test groups, thereby reducing the number of parts needed for qualification by that amount.
- b. Random samples shall be selected from resistors manufactured using normal equipment and processes and that have been subjected to and passed the requirements of Group A inspection. Samples shall not be selected until the production lot has also been subjected to and passed the requirements of Group B inspection.
- c. The samples selected for each qualification group shall be of the same tolerance, temperature coefficient of resistance and performance option and shall consist of:

55 or 50 parts (see 4.3.1a) of the highest resistance value being sought for qualification
55 or 50 parts (see 4.3.1a) of the lowest resistance value being sought for qualification

- 4.3.2 Test routine. Sample units shall be subjected to the qualification inspection specified in Table VII in the order shown. All sample units will be subjected to the inspections of Group 1. The samples shall then be subdivided as specified in Table VII and subjected to the inspections of Groups 2 through 10. Group 6 samples may be obtained in part or full from any of the other test groups.
- 4.3.3 Failures. Failures in excess of those allowed in Table VII shall be cause for refusal to grant qualification.
- 4.3.4 Retention of qualification. As a basis for retention of qualification, the manufacturer shall be requested to furnish a summary of QCI inspection results annually to the activity specified in 4.3.5. In addition, major process changes implemented since the previous reporting period shall be identified.
- 4.3.5 Qualifying Activity. Qualification test data and the qualification test samples shall be submitted to the following activity:
- NASA/GSFC
Greenbelt, MD 20771
Attn: QPLD Administrator
Code 562
- 4.3.6 Extension of qualification. Qualification of resistors to a given tolerance qualifies all looser tolerances; qualification of a given TCR qualifies all higher TCR's; and qualification to performance option E (see 1.7) qualifies performance option N.

Table VII. - Qualification inspection. 1/

Inspection	Requirement Paragraph	Method Paragraph	Number of Sample Units	Number of Defects Allowed 2/
<u>Group 1</u>				
Group A	4.4.4	See Table VIII	100%	N/A
<u>Group 2</u>				
Group B	4.4.5	See Table IX	See Table IX	3/
<u>Group 3</u>				
TCR	3.8	4.6.6		
Low Temperature Storage and Operation	3.11	4.6.9	10	1
Terminal Strength	3.12	4.6.10		
<u>Group 4</u>				
Dielectric Withstanding Voltage	3.9	4.6.7		
Insulation Resistance	3.10	4.6.8	10	1
Resistance to Soldering Heat	3.13	4.6.11		
Moisture Resistance	3.14	4.6.12		
<u>Group 5</u>				
Shock	3.15	4.6.13	10	1
Vibration	3.16	4.6.14		
<u>Group 6</u>				
Solderability	3.17	4.6.15	10 4/	1
Resistance to Solvents	3.18	4.6.16		
<u>Group 7</u>				
High Temperature Exposure	3.19	4.6.17	10	1
<u>Group 8</u> /5				
Current Noise	3.20	4.6.18	5 high value	0
Voltage Coefficient	3.21	4.6.19		
<u>Group 9</u> /5				
Thermal EMF	3.22	4.6.20	5 low value	0
<u>Group 10</u>				
Life	3.23	4.6.21	50	0

1/ Sample test quantities for Groups 3 through 10 shall be evenly divided between the highest and lowest resistance values being qualified.

2/ The aggregate total shall not exceed 2 defective units for the qualification samples.

3/ See paragraph 4.4.5.1.

4/ Samples may be selected from the other test groups.

5/ Applicable to performance option characteristic E only (see 1.7).

- 4.4 Quality conformance inspection (see 4.2). Quality Conformance Inspection (QCI) shall be performed on all product furnished to this specification.
- 4.4.1 Inspection of product for delivery. Inspection of product for delivery shall consist of Group A inspection per Table VIII and Group B inspection per Table IX.
- 4.4.2 Inspection lot. An inspection lot, as far as practical, shall consist of all the resistors of the same style, temperature characteristic, resistance blend and protective enclosure or coating and manufactured under essentially the same process and conditions during a manufacturing period of 1 month maximum.
- 4.4.3 Destructive Physical Analysis (DPA). NASA/GSFC may perform or have performed a DPA in accordance with GSFC S-311-M-70 or MIL-STD-1580 (or similar) on a sample of resistors from each part lot procured. The DPA will be performed to confirm that the requirements of this specification are adhered to by the manufacturer. Noncompliance with these DPA requirements shall be cause for lot rejection. The manufacturer has the right to review the DPA data and concur with the findings prior to lot disposition. Exceptions to the DPA criteria are shown below.
- a) Reduction in line width greater than 75% of the nominal line width shall be cause for rejection of the lot.
- 4.4.4 Group A inspection. Group A inspection shall consist of the examinations and tests specified in Table VIII and shall be performed in the order shown.
- 4.4.4.1 Subgroup 1 tests. Subgroup 1 tests shall be performed on 100 percent of the product supplied under this specification. Resistors that are out of resistance tolerance, or which experience a change in resistance greater than that permitted for the tests of this subgroup, shall be removed from the inspection lot. Only lots having not more than 5 percent rejects or one resistor, whichever is greater, that are rejected due to exceeding the specified resistance change limit as a result of Subgroup 1 tests, shall be supplied to this specification.
- 4.4.4.2 Subgroup 2 tests. Subgroup 2 inspections shall be performed on resistors passing Subgroup 1 inspections. A sample of 13 parts or 100% of the lot (whichever is less) shall be selected for this inspection. If one or more defects are found, then the entire lot shall be rescreened and defects removed. A new sample of 13 parts shall be selected and subjected to the Subgroup 2 inspection. In the event of one or more failures, the lot shall be rejected and shall not be supplied to this specification.

4.4.4.3 Subgroup 3 test: Six samples shall be selected randomly from each inspection lot and subjected to the Subgroup 3 solderability test. The manufacturer may use electrical rejects from Subgroup 1 screening tests for all or part of the samples to be used for solderability testing. If there are one or more defects, the lot shall be considered to have failed. However, the manufacturer has the option to rework the rejected lot in accordance with 4.4.4.3.1

4.4.4.3.1 Subgroup 3 lot rejections. In the event of one or more defects, the manufacturer has the option to rework the rejected lot. This rework shall consist of a documented solder dip process on 100% of the suspect lot which shall be made available to the qualifying activity if requested. After this rework, a new 6 piece sample shall be selected and subjected to the solderability test of Subgroup 3. If one or more parts fail this second test, then the lot shall be rejected and shall not be supplied to this specification.

4.4.4.3.2 Disposition of samples. The solderability test is considered a destructive test and samples submitted to the solderability test shall not be supplied to this specification.

Table VIII. - Group A inspection.

Inspection	Requirement Paragraph	Method Paragraph	Sample Size
<u>Subgroup 1</u>			
Thermal Shock	3.5	4.6.3	100% inspection
Overload	3.6	4.6.4	
Power Conditioning	3.7	4.6.5	
DC Resistance	3.4	4.6.2	
<u>Subgroup 2</u>			
Visual and Mechanical	3.2.1, 3.3, 3.3.1, 3.3.2 3.24, 3.25	4.6.1	13 visual or 100% (see 4.4.4.2) 3 mechanical
<u>Subgroup 3</u>			
Solderability	3.17	4.6.15	6

4.4.5 Group B inspection. Group B inspection shall consist of the examinations and tests specified in Table IX and shall be performed in the order shown.

4.4.5.1 Sample size. A random sample of 13 parts or 100% of the inspection lot (whichever is less) shall be selected for this inspection. If one or more defects are found, the lot shall be rescreened and defects removed. Another sample of the same size shall then be selected and inspected. If one or more defects are found in the second sample, the lot shall be rejected and shall not be supplied to this specification.

4.4.5.2 Disposition of sample units. Sample units which have been subjected to Group B inspection may be delivered to this specification provided the resistors are within resistance tolerance and meet requirements for visual and mechanical inspection.

Table IX. - Group B inspection.

Inspection	Requirement Paragraph	Method Paragraph	Sample Size
TCR	3.8	4.6.6	13

4.4.6 Inspection record. The manufacturer shall be required to maintain a record of all QCI inspection results for 7 years (see 4.3.4).

4.5 Periodic (annual) inspection

4.5.1 Group C inspection. Group C inspection shall consist of the inspections as specified in Table X, in the order shown.

4.5.2 Sample. The total number of samples required for Group C inspection is 40. The parts selected for Group C inspection shall meet the following criteria:

- Parts chosen from the tightest temperature characteristic produced during the previous 12 month production period.
- Twenty samples of the highest resistance value and 20 samples of the lowest resistance value produced during that time period shall be selected.
- Samples shall be selected from lots that have passed the Group A and Group B inspections.

4.5.3 Test routine. Sample units shall be subdivided as specified in Table X and subjected to the inspections of Groups 1 through 3.

4.5.4 Failures. The allowable number of defects shall be as indicated in Table X. A summary report of the results of Group C inspection shall be submitted to the qualifying activity as a basis for retention of qualification.

4.5.5 Waiver of Group C testing. Performance of the Group C testing specified herein may be waived with the approval of the qualifying activity (see 4.3.5) if the same or more stringent periodic testing is being performed in support of similar military specification devices such as MIL-PRF-122/1 or MIL-PRF-55182/9. If the waiver has been granted, then data from the military periodic inspection testing shall be submitted to the qualifying activity in lieu of performing the Group C inspection herein.

4.5.6 Disposition of Samples. Sample units which have been subjected to Group C inspection shall not be delivered on the contract or purchase order.

4.5.7 Noncompliance. If a sample fails to meet the Group C requirements, the manufacturer shall notify the qualifying activity within 5 working days of the failure occurrence.

Table X. Group C inspection. 1/

Inspection	Requirement Paragraph	Method Paragraph	Sample Size	Number of Defects Allowed
<u>Annually</u>				
<u>Subgroup 1</u>				
Life	3.23	4.6.21	10	0
<u>Subgroup 2</u>				
Resistance to Solder Heat	3.13	4.6.11	10	1
Moisture Resistance	3.14	4.6.12		
<u>Subgroup 3</u>				
High Temperature Exposure	3.19	4.6.17	10	1
<u>Subgroup 4</u>				
Dielectric Withstanding Voltage	3.9	4.6.7		
Insulation Resistance	3.10	4.6.8	10	1
Terminal Strength	3.12	4.6.10		

1/ Sample test quantities for Subgroups 1 through 4 shall be evenly divided between the highest and lowest resistance values being tested.

4.6 Methods of inspection.

4.6.1 External visual and mechanical inspection (see 3.2.1, 3.3, 3.3.1, 3.3.2, 3.24, 3.25). Resistors shall be examined to verify that materials, design, construction, physical dimensions, marking and workmanship are in accordance with the applicable requirements.

4.6.2 DC resistance (see 3.4). Resistors shall be tested in accordance with Method 303 of MIL-STD-202. The following details shall apply:

- a. The applicable test voltage shall not exceed 30 Vdc.
- b. Resistance shall be measured at a point 0.5 ± 0.125 inches from the lead egress.

4.6.3 Thermal shock (see 3.5). Resistors shall be tested in accordance with Method 107 of MIL-STD-202. The following details and exceptions shall apply:

- a. Measure DC resistance before test per 4.6.2.
- b. Resistors shall be mounted by any means other than soldering. Fixtures shall not prevent the samples from reaching the test temperature within 4 minutes of being placed in the test chamber.
- c. Test condition F.
- d. Examine each part for evidence of mechanical damage.

4.6.4 Overload (see 3.6). Resistors shall be tested as follows:

- a. Ambient test temperature shall be 20°C to 45°C.
- b. Apply 6.25 times rated power (see Table I) for 5 seconds. The maximum test voltage shall not exceed 450 Vdc.
- c. Measure DC resistance after test per 4.6.2.
- d. Examine each part for evidence of arcing, burning or charring.

4.6.5 Power conditioning (see 3.7). Resistors shall be tested as follows:

- a. Measure DC resistance before test per 4.6.2.
- b. Ambient test temperature shall be $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$.
- c. Apply a minimum of 1.0 Watt or 315 Vdc (whichever is less) for a minimum of 1 hour.
- d. Measure DC resistance after test per 4.6.2.
- e. Examine each part for evidence of arcing, burning or charring.

4.6.6 Temperature characteristic of resistance (see 3.8). Resistors shall be tested in accordance with Method 304 of MIL-STD-202 except as modified herein.

- a. For each measurement, the resistors shall be maintained at the applicable test temperature within $\pm 1^\circ\text{C}$ for 30 to 45 minutes prior to measuring the resistance. As an option, the manufacturer may develop a control procedure for minimum stabilization times required for this test. This procedure shall detail the specific time elements required to reach thermal and electrical stability for specific part designs. Documentation of this procedure shall be made available to the qualifying activity upon request.
- b. The first series of test temperatures shall be 25°C , -15°C , and -55°C .
- c. The second series shall be 25°C , 65°C , and 125°C .
- d. At the option of the manufacturer, the high temperature readings may be performed before the low temperature readings.
- e. The 25°C measurement for each series shall be used as the reference reading.

4.6.7 Dielectric withstanding voltage (see 3.9). Resistors shall be tested in accordance with Method 301 of MIL-STD-202. The following details and exceptions shall apply:

- a. Resistors under test shall be mounted between a pair of conductive metal straps in contact with the body of the resistor (see Figure 3). The straps shall be of such dimension that the body of the resistor does not extend beyond the edge of the straps.
- b. Applicable test voltage shall be 300 Vrms.
- c. Rate of voltage application 100 V/sec.
- d. Voltage shall be applied between the leads of the resistor shorted together and the metal straps.
- e. Duration of application of the test voltage shall be 1 minute.

4.6.8 Insulation resistance (see 3.10). Resistors shall be tested in accordance with Method 302 of MIL-STD-202. The following details and exceptions shall apply:

- a. Special preparations as specified in 4.6.7a.
- b. Applicable test voltage shall be 500 Vdc.
- c. Voltage shall be applied between the leads of the resistor shorted together and the metal straps.
- d. Duration of application of the test voltage shall be 2 minutes.
- e. The lowest reading observed two minutes or more after the application of the test voltage shall be recorded as a measure of the insulation resistance.

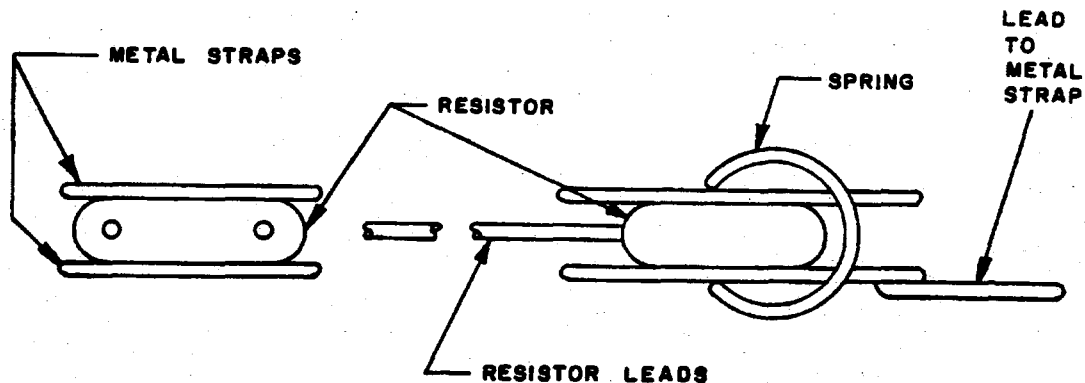


Figure 3. Mounting Straps for Moisture Resistance, Dielectric Withstanding Voltage and Insulation Resistance Tests.

4.6.9 Low temperature storage and operation (see 3.11). Resistors shall be tested as follows:

- a. Measure DC resistance before test per 4.6.2.
- b. Resistors shall be mounted by their terminals with at least 1 inch of free air space around each resistor. The mounting fixture shall be constructed in such a fashion as to minimize the obstruction of air flow across and around resistors when placed in the cold chamber for test.
- c. Resistors, mounted as specified in 4.6.9b, shall be placed in a cold chamber at room temperature. The temperature shall then be gradually decreased to -65°C ($+0^{\circ}$, -5°C) within a period of not less than 1.5 hours. After 24 hours of stabilization at the specified temperature, the full rated continuous working voltage specified in 3.3.5 shall be applied for 45 minutes (resistors may be loaded individually or in parallel). Within 15-20 minutes after removal of the voltage, the temperature in the chamber shall gradually be increased to room temperature within a period of not more than 8 hours. The resistors shall then be removed from the chamber and maintained at a temperature of $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for a period of approximately 24 hours.
- d. Measure DC resistance after test per 4.6.2.
- e. Examine each part for evidence of mechanical damage.

4.6.10 Terminal strength (see 3.12). Resistors shall be tested in accordance with Method 211 of MIL-STD-202. The following details and exceptions shall apply:

- a. Pull test:
 - 1) Measure DC resistance before test per 4.6.2.
 - 2) Test condition A. Applied force shall be 2.0 pounds.
 - 3) Measure DC resistance after test per 4.6.2.
- b. Twist test:
 - 1) Measure DC resistance before test per 4.6.2.
 - 2) Test condition D.
 - 3) Measure DC resistance after test per 4.6.2.
 - 4) Examine each part for evidence of breaking and loosening of terminals and chipping of coating.

4.6.11 Resistance to soldering heat (see 3.13). Resistors shall be tested in accordance with Method 210 of MIL-STD-202. The following details and exceptions shall apply:

- a. Measure DC resistance before test per 4.6.2.
- b. Sample units shall not have been soldered during any previous tests.
- c. Special Preparation: Both leads shall be dipped in flux and then dipped into solder, both for 5 seconds \pm 0.5 seconds. The solder bath shall be maintained at $260^{\circ}\text{C} \pm 5^{\circ}\text{C}$. Parts shall be immersed to within 0.075 inches from where the leads exit the body.
- d. Subject half of the test samples to Test condition A (Solder Iron).
- e. Subject the other half of the test samples to Test Condition C (Wave Solder-Top Side). A board with a maximum area of 9 square inches shall be used and the leads shall not be cut. Duration of the test shall be 10 ± 2 seconds.
- f. After completion of the cleaning process and a minimum 3 hour cooling period, measure DC resistance per 4.6.2.
- g. Examine each part for evidence of mechanical damage.

4.6.12 Moisture resistance (see 3.14). Resistors shall be tested in accordance with Method 106 of MIL-STD-202. The following details and exceptions shall apply:

- a. Resistors shall be mounted by soldering their leads to rigid mounts or terminal lugs. One half of the sample units shall have the resistor body covered by a polarizing strap (see Figure 3). The strap shall be made of corrosion resistant metal and kept in contact with the resistor body with a nonconducting, noncorrosive support whose width is less than that of the body and will not act as a moisture trap.
- b. DC resistance shall be measured per 4.6.2 immediately following the initial drying period.
- c. Polarization and loading voltage
 - 1) Polarization voltage: During steps 1 through 6 inclusive, a 100 Vdc potential shall be applied only to those resistors that have a polarizing strap. This potential shall be applied with the positive lead connected to the resistors terminals shorted together and the negative lead connected to the polarizing straps.

4.6.12 Moisture resistance (Continued)

- 2) Loading voltage: During the first 2 hours of steps 1 and 4, 100 percent of the rated power (see 3.3.4 and Table I) not to exceed the maximum rated voltage shall be applied only to those resistors that do not have a polarizing strap.
- d. Step 7b shall not be applicable. Step 7a shall be performed during any 5 of the first 9 cycles only. All polarizing straps shall be removed to perform step 7a and replaced prior to returning resistors to the humidity chamber.
- e. Upon completion of step 6 of the final cycle, the resistors shall be held at the high humidity condition and a temperature of 25°C for 1.5 to 3.5 hours. Resistors shall be removed from the test chamber within 0.5 hours and without any additional handling, be subjected to the DC resistance (see 4.6.2), DWV (see 4.6.7) and IR (see 4.6.8) tests.
- f. Examine each part for evidence of mechanical damage.

4.6.13 Shock (see 3.15). Resistors shall be tested in accordance with Method 213 of MIL-STD-202. The following details and exceptions shall apply:

- a. Resistors shall be rigidly mounted on appropriate jig fixtures with their leads supported at a distance of 0.250 inches from the resistor body. The resistor shall be mounted with the body clamped or cemented to a flat surface. Where used, the cement material shall not extend above the centerline in a vertical plane or beyond the resistor body ends in a horizontal plane. In no case shall the resistor body be completely encapsulated by the cement. These fixtures shall be constructed to insure that the points of the resistor mounting supports shall have the same motion as the shock table. Test leads used during this test shall be no larger than AWG size 22 stranded wire, so that the influence of the test lead on the resistor shall be held to a minimum. The test lead length shall be no greater than is necessary. In all cases, the resistors shall be mounted in relation to the test equipment so that the stress applied is in the direction that would be considered most detrimental.
- b. Measure DC resistance before test per 4.6.2.
- c. Subject samples to a total of 10 shocks in each of 2 mutually perpendicular planes; one perpendicular and the other parallel to the longitudinal axis of the resistor.
- d. Test condition I (100 G, 6 ms sawtooth).
- e. During shock testing each resistor shall be monitored to determine electrical discontinuity by a method that shall at least be sensitive enough to monitor or register, automatically, any electrical discontinuity of 0.1 ms or greater.
- f. Measure DC resistance after test per 4.6.2.
- g. Examine each part for evidence of mechanical and electrical damage.

4.6.14 Vibration (see 3.16). Resistors shall be tested in accordance with Method 204 of MIL-STD-202 at Test Condition D.

- a. Resistors shall be rigidly mounted on appropriate jig fixtures as specified in 4.6.13a. These fixtures shall be constructed to insure that the points of the resistor mounting supports shall have the same motion as the vibration table. The fixtures shall also be of a construction that shall preclude any resonance in the fixture when subjected to vibration within the test frequency range, and the fixture shall be monitored for these features on the vibration table. Test leads shall be as specified in 4.6.13a. A shielded cable, which may be necessary because of the field surrounding the vibration table, shall be clamped to the resistor mounting jig.
- b. Measure DC resistance before test per 4.6.2.
- c. Test condition D (10 to 2,000 Hz, 20 G).
- d. Vibrate samples in each of 2 mutually perpendicular planes; one perpendicular and the other parallel to the longitudinal axis of the resistor. Duration of test shall be 4 hours in each plane.
- e. During vibration testing each resistor shall be monitored to determine electrical discontinuity by a method that shall at least be sensitive enough to monitor or register, automatically, any electrical discontinuity of 0.1 ms or greater.
- f. Measure DC resistance after test per 4.6.2.
- g. Examine each part for evidence of mechanical damage.

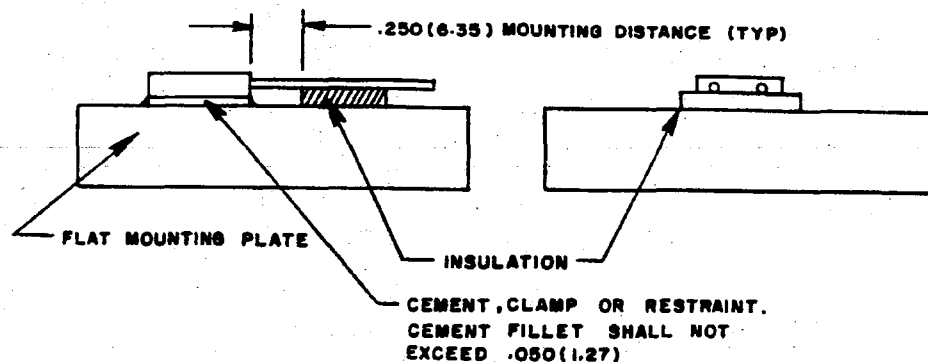


Figure 4. Mounting for Shock and Vibration Tests

4.6.15 Solderability (see 3.17). Resistors shall be tested in accordance with Method 208 of MIL-STD-202.

4.6.16 Resistance to solvents (see 3.18). Resistors shall be tested in accordance with Method 215 of MIL-STD-202. The following details shall apply:

- a. The marked portion of the resistor body shall be brushed.
- b. Examine each part for evidence of mechanical damage and legibility of marking.

4.6.17 High temperature exposure (see 3.19).

- a. Measure DC resistance before test per 4.6.2.
- b. Following initial resistance measurements, resistors shall be placed in a chamber maintained at +150°C, +5°C, -0°C, for a period of 2000 hours minimum with no load applied.
- c. After removal from the test chamber, the resistors shall be permitted to stabilize at room ambient temperature. Within 6 hours after removal from the chamber, resistors shall be subjected to dielectric withstanding voltage, insulation resistance, and DC resistance in accordance with paragraphs 4.6.7, 4.6.8, and 4.6.2, respectively.
- d. Examine each part for evidence of mechanical damage.

4.6.18 Current noise (see 3.20). Current noise shall be measured in accordance with Method 308 of MIL-STD-202.

4.6.19 Voltage coefficient (see 3.21). Resistors shall be tested in accordance with Method 309 of MIL-STD-202. The continuous working voltage shall be as specified in 3.3.5 and Table I.

4.6.20 Thermal EMF (see 3.22). Thermal EMF shall be measured in accordance with the applicable paragraph of MIL-PRF-122.

4.6.21 Life (see 3.23).

- a. Resistors shall be mounted in the test chamber so that the temperature of one resistor shall not appreciably influence the temperature of any other resistor. The voltage at the resistor terminals shall be at least 95 percent of the specified test voltage.
- b. Ambient test temperature shall be 125°C ± 5°C.
- c. Measure DC resistance before test at room temperature per 4.6.2. This initial measurement shall be the reference temperature for all subsequent measurements.
- d. Rated power (see 3.3.4) not to exceed maximum working voltage (see 3.3.5) shall be applied intermittently, 1.5 hours "on", 0.5 hours "off".

4.6.21 Life (Continued).

- e. Resistors shall be life tested for 2000 hours with samples continuing on test to 10000 hours.
- f. DC resistance shall be measured at the end of the 0.5 hours "off" cycle at 250, 500, 1000, 2000, 4000, 6000, 8000 and 10000 hours.
- g. After completion of extended life testing, examine each part for evidence of mechanical damage.

5. PACKAGING

- 5.1 Packaging. Packaging shall be in accordance with MIL-PRF-122. The preventive packaging requirements for electrostatic sensitive parts per MIL-R-39032 or equivalent shall be followed.
- 5.2 Packing. The packaged device shall be packed in shipping containers in a manner that will afford adequate protection from damage during direct shipment from the supply source to the first receiving activity. These packs shall conform to the applicable carrier rules and regulations.
- 5.3 Package marking. In addition to any special marking required by the purchase order, each unit package exterior container shall be clearly and legibly marked with at least the manufacturer's name or symbol, the selected item part number with applicable dash number and the procuring activity's purchase order number.

6. NOTES

- 6.1 Ordering data. Acquisition documents should specify the following:
 - a. Number, title, and date of this specification.
 - b. Goddard Part Number
 - c. Quantity
- 6.2 Qualification provisions. With respect to product requiring qualification, awards will be made only for product which have been tested and approved by GSFC before the time for opening of bids. The attention of the suppliers is called to the following requirement: manufacturers should arrange to have qualification tests made on product which they propose to offer to GSFC to become eligible for awards of contracts or orders for product covered by this specification. The manufacturer shall bear the cost of qualification inspection to this specification. Information pertaining to qualification of product may be obtained from the activity whose address is listed in 4.3.5.

6.3 **NOTICE.** When GSFC drawings, specifications, or other data are sent for any purpose other than in connection with a definitely related GSFC procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever. The fact that GSFC might have formulated, furnished or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any person or corporation, or conveying any right or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

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